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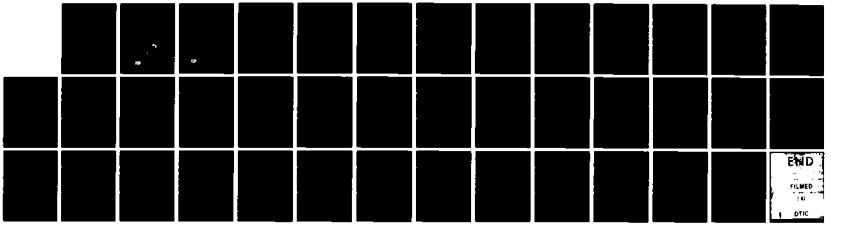

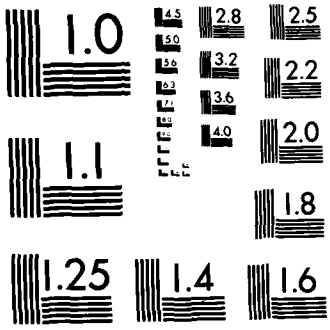

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PROFESSIONAL PAPER 364 / October 1982

THE MILITARY'S MONOPSONY POWER

Aline Quester
Michael Nakada

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THE MILITARY'S MONOPSONY POWER

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Naval Studies Group

CENTER FOR NAVAL ANALYSES

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An so, having made my plea, let me salute the profession with what might well have been the title of this paper, with what is certainly the key that points to the solution of most problems in applied welfare economics, with what surely should be the motto of any society that we applied welfare economists might form, and what probably, if only we could learn to pronounce it, should be our password:

$$\text{"} \int_{z=0}^{z^*} \sum_i D_i(z) \frac{\partial X_i}{\partial z} \, dz. \text{"}$$

Harberger, 1971

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Introduction

Since the inception of the AVF the issue of military compensation, its current remuneration and the size of future increases, comes up for annual Congressional debate. The competing civilian sector forces military pay toward parity lest shortfalls and attrition take their toll. Central to the issue of remuneration and a proposed increase is its effect on accessions and retention. The effectiveness of military pay has brought back the debate between the All Volunteer Force (AVF) and the draft. Surely, given a fixed military budget, there are competing demands on these resources, i.e., hardware procurement and soldiers to man them.

It is the purpose of this paper, then, to examine the labor market behavior of the military services combined. To date, the military attracts an average of a quarter of a million 17-21 year-old non-prior service high school graduate males annually. The total size of our armed forces numbers two million. Exclusive of military retirement payments, the size of the military's wage bill in FY 81 is nearly 34 billion dollars. This sum is 20 percent of DoD's total FY 81 budget of 171.2 billion dollars.

Suppose we focus on the issue of military pay and accessions. The debate between the AVF and the draft is only credible here. Were the military were a perfect competitor for labor, any failure on the part of

the military to pay the competitive wage would doom the AVF. Indeed, the military would face a completely elastic supply curve at the going wage. An examination of empirical estimates, however, reveals elasticities of supply estimates for this age group considerably less than infinity. Most estimates, in fact, are about one (See Goldberg, 1981).

The only conclusion, then, is the military does face an upward sloping labor supply curve and, to the extent that increasing military pay increases enlistments, the military does wield some power in the labor market. This power has been analyzed within the framework of a monopsony model by Thomas Borcherding (1971) and Richard Cooper (1975). Thomas Borcherding "calculated" the deadweight burden associated with the monopsonistic purchase of volunteers and "compared" the magnitude of this loss to the loss associated with the over-employment of labor under conscription. The "calculations" and "comparisons" in the Borcherding paper are pictorial and not numerical. Richard Cooper provided a more detailed and numerical comparison of these two losses.

While we are satisfied with Cooper's analysis of the social cost of the draft, we believe his analysis of an All Volunteer Force devoted insufficient attention to the linkages between military and civilian wages. In this paper we develop those linkages, exploring the extent of the military's monopsony power in an economy-wide framework.

Monopsony

The monopsonist firm faces an upward sloping supply of labor curve. If it wants more labor, it must pay more. In contrast, the competitive firm faces a perfectly elastic supply of labor. That is, at the equilibrium (market) wage, the firm can obtain all the labor it wants. The presumption is that a change in the firm's demand will not influence the wage because the individual firm buys a small fraction of the available labor. The U.S. military currently employs approximately 6 percent of non-prior service male youths 17-21 years old. However, when focusing only on those in this age group who work full-time, the military's employment rises from 6 percent to about 20 percent. Thus the military is a substantial employer of youth labor. In what sense, then, can we apply the monopsony model to the military? Consider first the textbook monopsony model.

Such pure monopsony models suggest that there is a single employer of labor; company towns in the coal mining areas of the country have often been utilized as examples. Figure 1 illustrates this pure case. The monopsonist faces an upward sloping supply of labor curve as higher wages induce workers to substitute work for "leisure." A profit maximizer, the firm equates the marginal return from labor (the marginal

revenue product curve) to the marginal cost of labor.* (The supply curve is the average cost of labor curve; when average costs are rising, marginal costs are above average costs. In the linear case, marginal costs are increasing at double the rate of average costs.)

This first order condition determines the level of employment. Since the employer will pay no more for the labor than he has to, he will pay his workers W_m. When compared to the monopsonist, a competitive solution would involve both increased employment (E_c) and a higher wage (W_c). The monopsonist will exist as long as workers lack alternative employment opportunities.

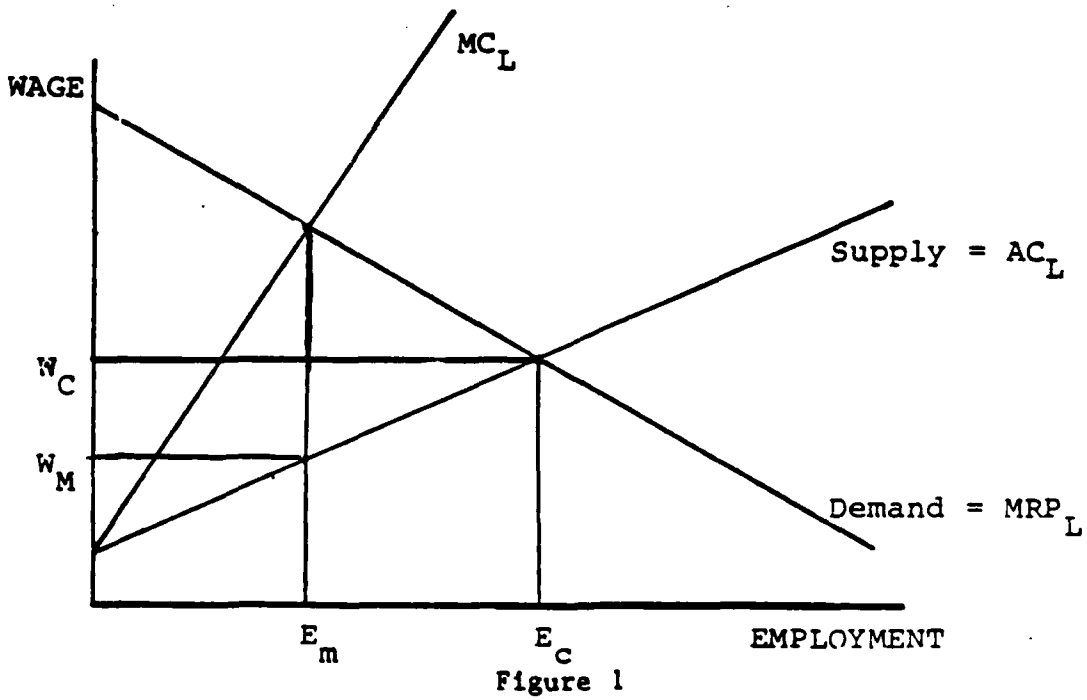

Figure 1

*Note that, in the monopsony case, the monopsonist has no demand curve for labor. That is, there is no longer a unique relationship between the quantity of labor demanded and its price. This is analogous to the absence of a supply curve for a monopolist in the product market.

This pure monopsonist model seems inappropriate for the problem at hand. Since there are alternative employers (and thus alternative wages) for youth, the military could not pay less than other employers and hope to obtain enlistees.* In short, a voluntary military cannot monopsonize the youth labor market, setting its compensation in a vacuum from other firms. For the existence of a stable solution, wages for equally productive workers must be equal across employers, but the pure monopsony model assumes away these other employers. Consider, then, a dominant firm monopsony model based on dominant product pricing models.

The Dominant Firm Monopsony

The model begins with three relationships: (1) a U.S. supply of labor curve for homogeneous labor (mental group, HSG, etc.),** (2) a demand for labor by the military, and (3) a demand for labor by the other small firms. These demand curves are the marginal revenue product curves for homogeneous labor. Next we derive a labor supply curve for the military by subtracting the demand for labor by the small firms from the total supply of labor. (In the diagram on the following page, the supply of labor to the military, S_{DoD}, is the horizontal difference between $S_{u.s.}$ and D_{sm}.) Since the average cost of labor is rising, the

*Of course, under conscription, the military can utilize any compensation scheme.

**We assume here that an individual's marginal product is invariant to the sector in which he works. That is, the military and civilian sectors have similar valuations of individual productivity.

military, as the dominant employer, is in a position to exert some power (see figure 2).*

The military equates the marginal cost of labor to the marginal revenue product of labor to determine employment, Q_{DoD}. To obtain this amount of labor, the military pays the wage associated with Q_{DoD} on its supply curve, W^{dom}_{mono}. The wage is then transmitted as the price for this homogeneous labor to the small firms who obtain all the workers they want at this price. (Note that the equilibrium solution is guaranteed because the military supply curve was constructed to be the difference between the total supply curve and the small firms' demand curve.)**

The wage and employment are both somewhat lower than they would be in the competitive case. The competitive wage is determined by the intersection of the military's supply and demand for labor. Alternatively, it can be derived by adding the military's demand to the small firm's demand and looking at the intersection of the demand and supply curves. An increase in the military's demand for labor simply

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*Our formulation abstracts from non-pecuniary aspects of employment. In particular, wages need not equalize across civilian and military markets if there is sufficient homogeneity in the tastes or distastes for military versus civilian life.

**Following the dominant firm model, we have formulated the military's supply curve as an excess supply curve. This formulation suggests that, among equally productive workers, those with the highest reservation wages are found in the military sector. Lottery assignment to the civilian and military sectors would result in a lower DOD wage.

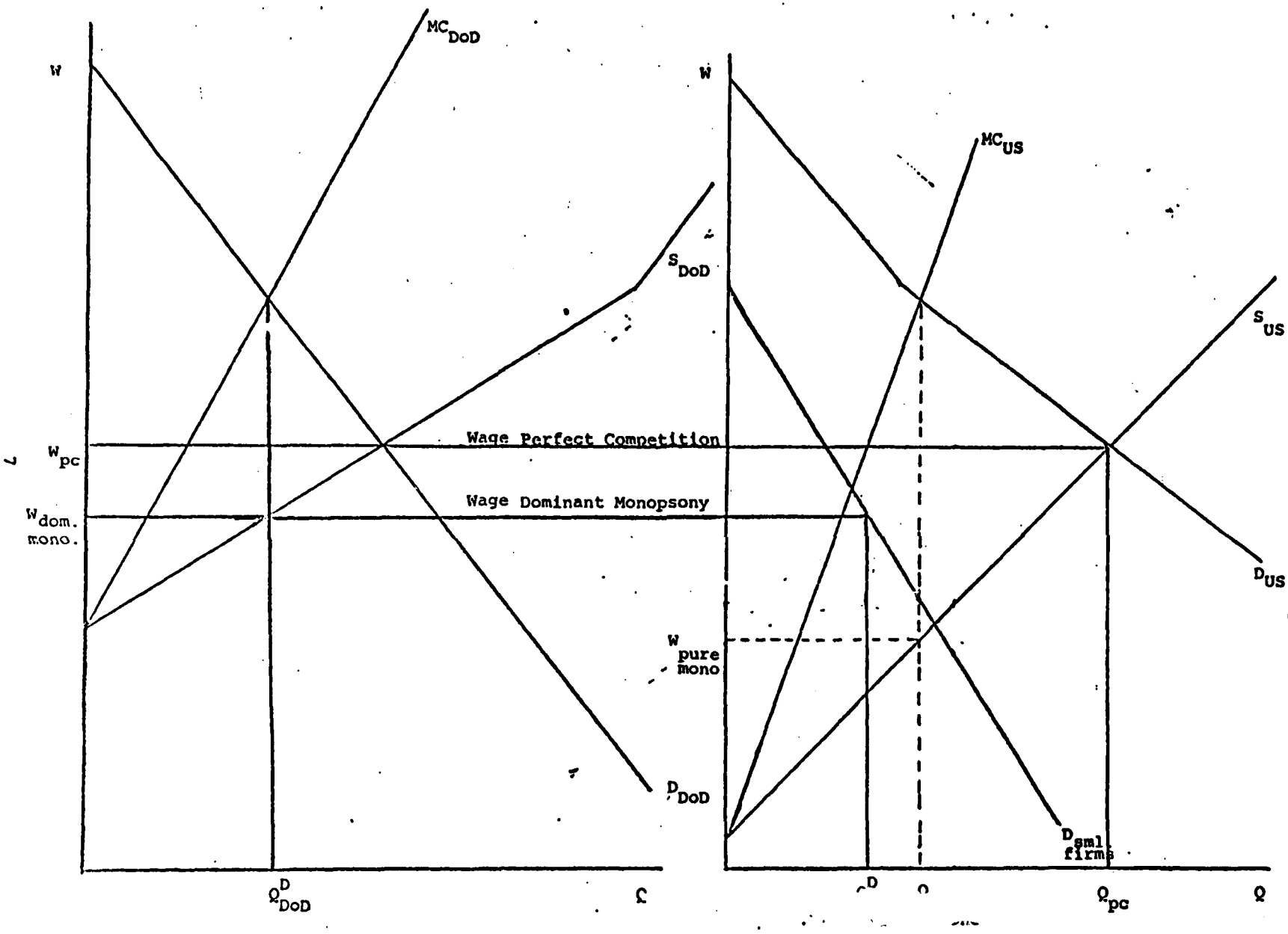

Figure 2

Solutions for the military as a pure monopsonist, dominant firm monopsonist, and perfect competitor.

involves a new calculation (determine employment by the intersection of MC_{DoD} and MRP_{DoD} and determine the wage by the supply of labor to the military).

How much monopsony power does the military have? By monopsony power we mean the ability to deviate from a competitive equilibrium, to move toward a pure monopsony equilibrium. The military's monopsony power depends upon the size of its demand relative to the total demand for this type of labor, on the supply elasticity, and on the elasticities of demand (the military's and the small firms'). Even with linear curves, however, price and employment deviations are complex functions of these variables, and we've no easily interpretable results (see appendix A for the linear and general solutions).

One general complaint about this genre of models has been the lack of an explanation of how the situation arose. This problem seems less severe here as there is no confusion about how the military became the dominant firm. As a substantial employer of youth labor, the military saw that it could reduce its costs by pursuing a monopsonist strategy. The solution is stable and profit- or value-maximizing. Thus, we would argue that the military behaves as a dominant firm monopsonist. Whether or not it is appropriate that the military behave as a monopsonist is the next issue. Consider first the question of equity.

The Monopsonist Military: Equity and Efficiency

When the military behaves as a dominant firm monopsonist rather than as a competitive employer, the wages of youth are lowered (see figure 2). Youth employment is also lower, but this is a voluntary response to a reduced wage. One can think of this lower wage as being a uniform tax on youth, a tax which helps pay for defense. While not only the young benefit from defense, in a life cycle framework, the "tax" is fair. That is, during our youth, we all "paid" the "tax." Moreover, youth wages would be considerably lower if the military stopped demanding youth labor. In short, it seems difficult to argue against the monopsony model on equity grounds.

Since monopsonist solutions move us away from competitive Pareto optimums, there are still the questions of efficiency. Figure 3 illustrates the welfare or dead weight loss involved in the military moving from a competitive to a dominant firm monopsony.* Before investigating the size of this welfare loss, however, let us consider the military's possibilities for price discrimination.

If the military could act as a perfect price discriminator, the supply curve would become the marginal cost curve. There were be no welfare loss, and the solution would differ from the competitive only in

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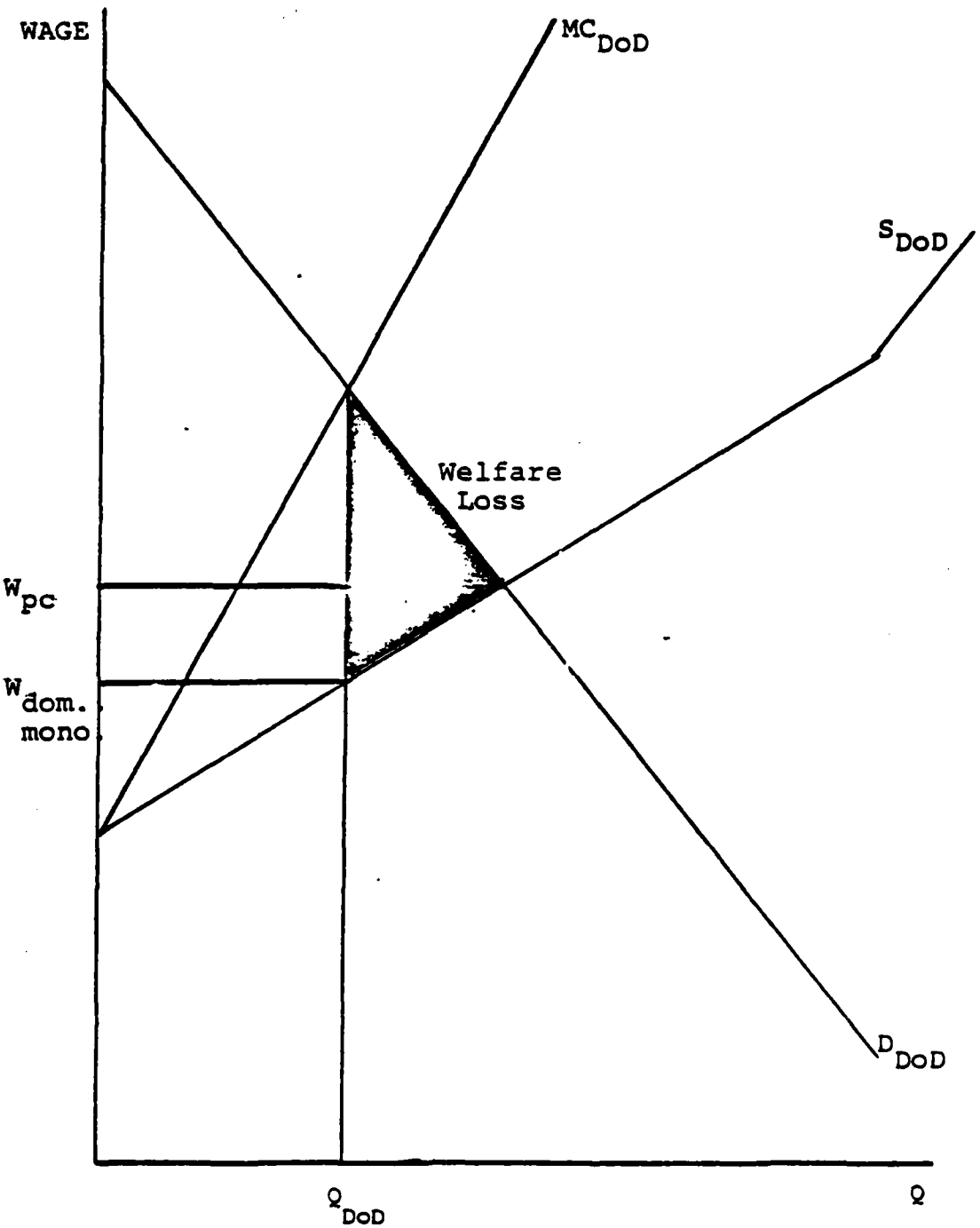
*Note that if the military's demand for labor is fixed (completely inelastic), there is no welfare loss.



The Welfare Loss Under tne Dominant Firm Monopsony Model

Figure 3

the distribution of the surplus (all labor surplus is extracted by the military). The extent to which the military practices price discrimination, then, determines the extent to which the marginal cost and average costs of labor differ. Cooper argues that the military does price discriminate:

> Enlistment bonuses for the combat arms occupational specialties are limited to individuals who are high school graduates and who score average or above average on the mental aptitude examinations, those individuals one would expect to have higher reservation wages. Similarly, those with higher mental aptitude scores and educational achievement generally receive the better jobs. Finally, recruiters are usually authorized only a limited number of slots for the shorter enlistment tours, with the result that these shorter enlistments are given only to those individuals who appear otherwise reluctant to join — hence, those with higher reservation wages. These are but a few of the many ways the military has of discriminating according to supply price. (Richard Cooper, The Social Cost of Maintaining a Military Labor Force, Rand R-1758-ARPA, August, 1975.)

While Cooper's examples suggest that the military is able to vary compensation (to provide a more attractive package to recruits with higher reservation wages), we are not convinced that this is price discrimination. Price discrimination involves compensating equally productive individuals differently; it does not mean compensating differentially productive employees differently. These two phenomena must be distinguished in order to evaluate possibilities for reduction in the size of the welfare loss.

We will consider two cases. The first assumes the military regards the productivity of all first term enlistees as identical while the civilian sector recognizes heterogeneity in the labor productivity of this age group. The second case assumes identical evaluations of productivity by the civilian and military sectors. That is, both sectors evaluate productivity of this age group to be heterogeneous, or both sectors evaluate productivity to be homogeneous. The important point is that both sectors have the same point of view.

Homogeneous Military Productivity and Heterogeneous Civilian Productivity

This assumption, although rarely explicated, appears fairly common in the literature.* Cooper, for example, implicitly suggests that an individual's position on the military's supply of labor curve is determined by his civilian productivity (plus a taste factor).** If it

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*Hansen and Weisbrod (1967) are an exception. In discussing the distributive and allocative effects of the draft, they explicitly draw a "supply curve" of labor in which an individual's position on the curve is determined by his civilian productivity. They then show that the actual civilian output foregone under a lottery draft is considerably greater than would be necessary. The efficient solution is to select the lowest civilian productivity individuals into the military, given a base level of competence defined by mental group or education.

Hansen and Weisbrod's argument is correct only under the assumption that military productivity is constant across individuals, e.g., that it is invariant to civilian productivity. That is, they can draw one supply curve for military labor only if all individuals on that supply are homogeneous in the production of military output.

**The fact that Cooper places these individuals on the same supply curve (for which the military has just one demand curve) means that the military regards these individuals as homogeneous in production.

is true that the military's demand for enlistees is invariant to the enlistee's characteristics, then Cooper is correct that the military can substantially reduce the size of the welfare loss by price discriminating with the mechanisms he mentions.* Here, one notes that the military fills its ranks from the bottom up, taking those who are least productive in the civilian world.

Currently the military is not accessing only the least productive, and Congressional directives aside, examination of the military's personnel needs indicate that today's military cannot be fully staffed by such individuals. While some military jobs can be filled by less able individuals, the military seems to require an overall ability mix similar to the civilian world. This suggests that the homogeneous military productivity assumption could be rejected.

Identical Evaluations of Productivity by the Civilian and Military Sectors

In this case, the military and the civilian sectors find individuals of given demographic characteristics equally productive. Consider eight labor categories, each defined by high school graduation (or not) and by mental groups (I-IV). Assume, next, that for each of

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*Under these productivity assumptions, the military's labor supply curve is derived by the horizontal addition of the differences between overall supply and the other firms' demand for each type of labor: the degree of non-homogeneity in civilian productivities determines the number of terms in the summation.

these eight labor markets, the military makes its hiring and wage decisions based upon the dominant firm monopsony model illustrated in figure 2.

This process generates eight equilibrium wages: military and civilian wages equalize for comparable employees. While military base pay is the same for enlistees in any of the eight productivity groups, total compensation is not. The mechanisms that Cooper refers to as price discrimination tools are instead the mechanisms by which the military adjusts pay to bring its compensation structure into line with the private sector's. Individuals whose private sector alternative wage is below base pay are assigned jobs with negative non-pecuniary aspects; individuals whose private sector alternatives are greater than base pay are assigned to ratings with large training components, given their location preferences, etc. Bonuses or shorter enlistments are not evidence of price discrimination. Instead, these mechanisms are the tools which the military uses to maintain pay comparability, to keep itself competitive with the private sector.

What scope is left, then, for price discrimination? Could the military price discriminate on any of these supply curves, supply curves which are drawn for individuals with the same alternative civilian wage offers? We would suggest that the answer is no. In order to do so, the military would need some mechanism which revealed how these individuals valued their time, how their reservation wages, given civilian wage

offers, differed. Since no such mechanisms occur to us, we conclude that a monopsonistic military has few possibilities for price discrimination.*

Calculating the Welfare Loss

We have argued that the military behaves as a dominant firm monopsonist in the market for 17-21 year old labor. This suggested a dead weight loss unless the military could price discriminate, a possibility we, in general, reject. It seems now appropriate to calculate the value of the loss.

To do this we have combined past empirical work with theoretical formulations and some "good" guesses. We utilized Larry Goldberg's estimated relationship between accessions of 17-21 year-old non-prior service high school graduate males and wages in order to locate the supply of labor to the military. From this supply curve we constructed the implied marginal cost curve (figure 4). The intersection of the

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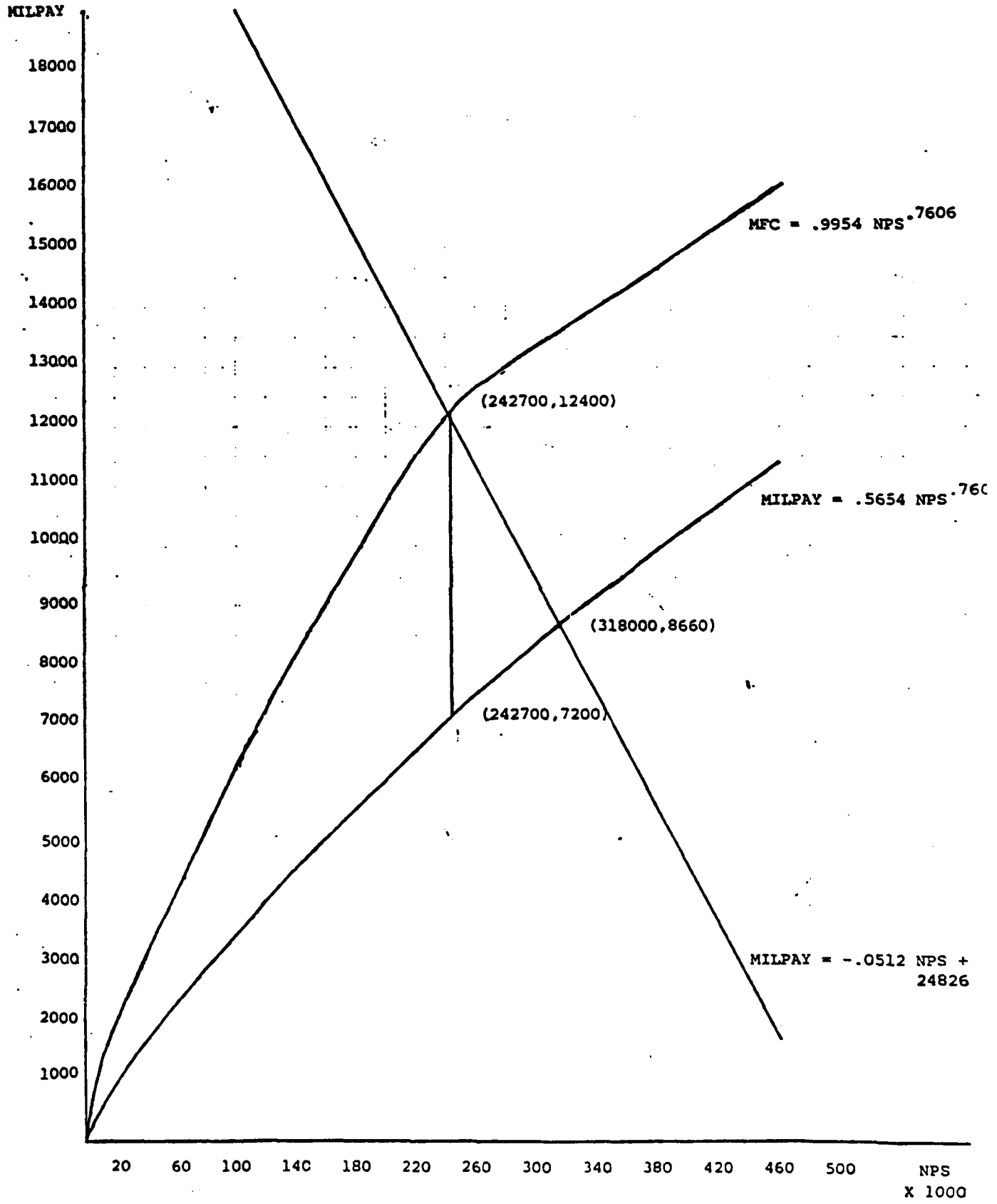
*We do not explicitly discuss the career force. We do feel, however, that the military has the scope here for price discrimination. Career compensation is varied by rating: inducements are provided for ratings which are hard to fill (very unpleasant or excellent civilian wage offers). Only if one can envisage a supply curve of careerists which contained all careerists (implying the military sees hospital corpsmen and boiler technicians as perfect substitutes) is it price discrimination to pay different wages to different ratings.


MILPAY
18000
17000
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15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
MFC = .9954 NPS^.7606
(242700,12400)
MILPAY = .5654 NPS^.760
(318000,8660)
(242700,7200)
MILPAY = -.0512 NPS + 24826
20
60
100
140
180
220
260
300
340
380
420
460
500
NPS
X 1000

Figure 4

military's marginal cost of labor curve and the military's (Marginal Revenue Product) MRP ("demand") curve has coordinates (242700,12400). We identify the military's MRP curve by this point and by its elasticity.* To calculate the elasticity, we use a formula for derived demand that was first suggested by Hicks.

The elasticity of military's derived demand for labor (λ) is a function of the elasticity of demand for the final output (η), the elasticity of the supply of capital (ε), labor's share in total costs (s), and the elasticity of substitution between capital and labor (σ). The Hicks' formula appears below. A discussion of the values we assumed for the four variables follows.

$$\lambda = \frac{-\sigma\eta + \varepsilon(s\eta - (1-s)\sigma)}{(-s\sigma + (1-s)\eta) + \varepsilon}$$

We will evaluate the welfare loss at a long run equilibrium position. In the long run we expect the elasticity of the supply of capital (ε) to be infinite. While the military buys rather specialized capital, the military's position as a buyer of capital is not one of a dominant firm in the economy. The assumption that the supply of capital is infinitely elastic simplifies the formula for λ as follows:

$$\lambda = s\eta - (1-s)\sigma$$

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*By taking a linear approximation to the demand curve at this point, the curve is identified by a point and it's elasticity.

There are no empirical estimates for σ, the military's elasticity of substitution between capital and labor. Estimates of σ for other sectors of the economy have yielded a fairly wide range of estimates, .14 to 13.7 for the elasticity of substitution between blue collar workers and capital. The range of these estimates is somewhat misleading, however, as the majority of studies have estimated σ between .5 and 3.* Believing that the military probably has less substitution possibilities than other firms, we will take σ equal to one.**

The remaining parameter is η, the price elasticity of demand for defense. In the long run, we have kept our total real expenditures for defense constant. This implies an elasticity of one. These parameter values suggest that the elasticity of the derived demand for labor by the military is one. With a linear approximation of the demand curve, as is sketched in figure 4, we now possess the necessary information to determine the size of the welfare loss.

The calculations of the welfare loss are found in appendix B. Estimates range between 200 and 250 million dollars. Relative to the size of the military's wage bill for new recruits, this welfare loss is

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*Daniel S. Hamermesh and James Grant, "Econometric Studies of Labor-Labor Substitution and their Implications for Policy," The Journal of Human Resources, Summer, 1979:519-542.

**We choose to be conservative, because we want a lower bound estimate of the size of the welfare loss: A larger value for sigma produces a more elastic demand curve and thus a larger dead weight loss.

12 to 15 percent. These welfare losses appear fairly large, certainly much larger than the losses estimated for product market monopoly.*

Of course, if we compared the 250 million dollars to the total cost of defense, the losses would appear considerably less important. Such a comparison, however, would require calculating an additional dead weight loss since all evidence indicates that the military also faces an upward sloping supply curve for careerists. The size of this total loss relative to the total FY 81 DoD budget will be smaller than our 12 to 15 percent. However, we speculate that that percent will not be as insignificant as Harberger's.

Concluding Comments

On efficiency grounds should the military, as a provider of a public good, ignore its potential monopsony power because of resulting inefficiencies? More basically, does the military currently "profit maximize" and exploit it's monopsony power? In product markets one compares price and marginal cost. Here one should compare the

---

*Harberger (1954) estimated the welfare losses from product market monopoly at .1 percent of GNP. Since then differing methodologies and assumptions have produced estimates similar to Harberger's (Schwartman, 1960; Scherer, 1970; and Worcester, 1973) as well as estimates in the 6-7 percent range (Stigler, 1956; Kamerschen, 1966; and Cowling and Mueller, 1978).

enlistee's marginal revenue product with his wage. Unfortunately, data deficiencies preclude such comparisons. Thus, although we cannot prove that the military does exploit what power it has, we will assume, as most researchers appear to, that it does.

Clearly, the military, and society in general, can be made better off by moving to the competitive equilibrium, the Pareto optimal solution. However, even if the competitive solution is not politically possible, the present monopsony solution for the AVF is preferred to a draft. Cooper's 1975 analysis has shown that the draft is not the better alternative to the AVF. He demonstrates that the welfare loss associated with a draft will exceed the welfare loss associated with the All Volunteer Force.

APPENDIX A

THE DOMINANT FIRM MONOPSONY

General	Linear
Let Q = quantity; W = wage	
I. U.S. supply of labor	
$Q^S_{US}=f_1(W);\ W^S_{US}=g_1(Q)$	$Q^S_{US}=a+bW;\ W^S_{US}=\frac{1}{b}Q-\frac{a}{b}$ $a<0, b>0$
II. Total firm demand for labor	
$Q^D_F=f_2(W);\ W^D_F=g_2(Q)$	$Q^D_F=c+dW;\ W^D_F=\frac{1}{d}Q-\frac{c}{d}$ $c>0, d<0$
III. Military's demand for labor	
$Q^D_{DoD}=f_3(W);\ W^D_{DoD}=g_3(Q)$	$Q^D_{DoD}=e+fW;\ W^D_{DoD}=\frac{1}{f}Q-\frac{e}{f}$ $e>0, f<0$
IV. Determine supply of labor to the military	
$Q^S_{DoD}=f_4(W)=Q^S_{US}-Q^D_F$	$Q^S_{DoD}=(a+bW)-(c+dW)$ $=(a-c)+(b-d)W$ Let $h=b-d>0$ $k=a-c<0$

General	Linear
$W^S_{DoD} = g_4(Q)$	$W^S_{DoD} = \frac{1}{h} Q - \frac{k}{h}$

V. Solve for quantity of labor employed by the military. First order condition: military's demand for labor equals military's marginal cost of labor.

A. Military's Cost of labor, C_{DoD}

$$C_{DoD} = Q.W^S_{DoD} = Q.g_4(Q) \qquad C_{DoD} = Q(\frac{1}{h}Q - \frac{k}{h})$$

B. Military's marginal cost of labor = $\frac{dC_{DoD}}{dQ}$

$$\frac{dC_{DoD}}{dQ} = W^S_{DoD} + Q.g_4'(Q) \qquad \frac{dC_{DoD}}{dQ} = \frac{1}{h} Q - \frac{k}{h} + Q\frac{1}{h}$$
$$= \frac{2}{h} Q - \frac{k}{h}$$

C. First order condition: solve for Q*

$$g_3(Q^*) = W^S_{DoD} + Q.g_4'(Q) \qquad \frac{1}{f} Q - \frac{e}{f} = \frac{2Q}{h} - \frac{k}{h}$$
$$= g_4(Q^*) + Q^*.g_4'(Q^*) \qquad Q^* = \frac{he-fk}{h-2f}$$

VI. Solve for wage military pays: substitute Q from step C into military's supply of labor.

General	Linear
$W^{S*}_{DoD} = g_4(Q^*)$	$W^{S*}_{DoD} = \frac{1}{h}\left(\frac{he-fk}{h-2f}\right) - \frac{k}{h}$
	$= \frac{(he-fk) - k(h-2f)}{h(h-2f)}$
	$= \frac{he+fk-kh}{h(h-2f)}$

VII. Quantity demanded by firms

$$Q^{D*}_f = f_2(W^{S*}_{DoD}) \qquad Q^{D*}_F = c + d\left[\frac{he+fk-kh}{h(h-2f)}\right]$$

VIII. For the linear case only, show $Q^S_{US} = Q^S_{DoD} + Q^D_F$ (Step IV).

$$a+b\left[\frac{he+fk-kh}{h(h-2f)}\right] \stackrel{?}{=} k+h\left[\frac{he+fk-kh}{h(h-2f)}\right] + c+d\left[\frac{he+fk-kh}{h(h-2f)}\right]$$

$$\frac{ah(h-2f)+b\ (he+fk-kh)}{h(h-2f)} \stackrel{?}{=} \frac{h(k+c)(h-2f)+(h+d)(he+fk-kh)}{h(h-2f)}$$

Show: $ah(h-2f)+b(he+fk-kh) \stackrel{?}{=} h(k+c)(h-2f)+(h+d)(he+fk-kh)$

Show: $ah \stackrel{?}{=} h(k+c)$ and $b \stackrel{?}{=} (h+d)$

But $k = a-c$ and $h = b-d$ from IV.

IX. Let Q^*_{COMP} = equilibrium quantity employed under pure competition

Q^*_{MONO} = equilibrium quantity employed under dominant firm monopsony

W^*_{COMP} = equilibrium wage under pure competition

W^*_{MONO} = equilibrium wage under dominant firm monopsony

Find $\frac{Q^*_{MONO}}{Q^*_{COMP}}$ and $\frac{W^*_{MONO}}{W^*_{COMP}}$ for linear case only.

A. Find Q^*_{COMP} and W^*_{COMP} by equating demand and supply of labor by the military.

$$W^D_{DoD} = W^S_{DoD}$$

$$\frac{1}{f}Q - \frac{e}{f} = \frac{1}{h}Q - \frac{k}{h}$$

$$Q^*_{COMP} = \frac{he-fk}{h-f}$$

$$W^*_{Comp} = \frac{1}{h}\left(\frac{he-fk}{h-f}\right) - \frac{k}{h}$$

$$W^*_{COMP} = \frac{he-fk-k(h-f)}{h(h-f)}$$

$$= \frac{e-k}{h-f}$$

B. $$\frac{Q^*_{MONO}}{Q^*_{COMP}} = \frac{\frac{he-fk}{h-2f}}{\frac{he-fk}{h-f}}$$

$$= \frac{h-f}{h-2f} < 1; \quad \frac{h-f}{h-2f} > 0$$

C. $$\frac{W^*_{MONO}}{W^*_{COMP}} = \frac{\frac{he+fk-kh}{h(h-2f)}}{\frac{e-k}{h-f}}$$

$$= \frac{(he+fk-kh)(h-f)}{h(e-k)(h-2f)}$$

$$= \frac{h^2e-h^2k+2fhk-f(fk-he)}{h^2e-h^2k+2fhk-2efh}$$

$\frac{W^*_{MONO}}{W^*_{COMP}}$ depends on sgn (fk-he)

But from V.C he-fk > 0 for a stable solution.

Hence, (fk-he) < 0.

$$\therefore 0 < \frac{W^*_{MONO}}{W^*_{COMP}} < 1$$

APPENDIX B

I. Welfare Loss, WL, by area of triangle:

$WL = 1/2bh$

$= 1/2\ (5200)(75300)$

$= \$195,780,000$

II. Welfare Loss, WL, by formulation ala D. Clay-Mendez:

$$WL = \frac{1}{2}\left[\frac{Rt\varepsilon_D}{1+\frac{\varepsilon_D}{\varepsilon_S}}\right]$$ where R = amount of "tax"

t = "tax" rate

ε_D = elasticity of demand for labor

ε_S = elasticity of supply for labor

$$\frac{1}{2}\left[\frac{(242,700)(5200)(1)\left(\frac{5200}{7200}\right)}{1+\frac{1}{1.31467}}\right]$$

$= \$258,845,080$

III. Welfare Loss, WL, by Musgrave's formula:

$$WL = \frac{1}{2} \frac{\varepsilon_D \varepsilon_S}{\varepsilon_D + \varepsilon_S} \frac{R^2}{N}$$ where R = amount of "tax"

N = total amount paid including "tax"

ε_D = elasticity of demand for labor

ε_S = elasticity of supply for labor.

$$= \frac{1}{2} \frac{(1)(1.31467)}{1 + 1.31467} \frac{(5200 \times 242700)^2}{(12400 \times 242700)}$$

= $197,640,460

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